
Sustainability and the financial system

Abstract of the London discussion

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This abstract relates to the following paper: Aspinall, N.G., Jones, S.R., McNeill, E.H., Werner, R.A. and Zalk, T., Sustainability and the financial system: Review of literature 2015. *British Actuarial Journal*. doi: 10.1017/S1357321718000028

The Chairman (Mr C. J. Hitchen, F.I.A.): I am Chief Executive of Railway Pensions Management Limited, which runs the railways pension scheme in the United Kingdom. Sustainability and the financial system is pretty important to me, and sustainability, in particular, is something I worry about quite a lot as people are relying on me to pay pensions sustainably for, frankly, the rest of this century.

The authors are Nico Aspinall, Hugh McNeill, Simon Jones, Tracy Zalk and Richard Werner. The first speaker is Hugh McNeill. He has been involved in the work here since 2010 with the setting up of a resource and environment group. This is the second literature review in which Hugh has been involved. In his spare time Hugh enjoys studying and teaching courses in economics with justice and recently co-developed a 5-week public course relating to the interaction of the environment energy input in the economic system.

Mr E. H. McNeill, F.I.A.: The paper today is the first piece of research commissioned by the Resource and Environment Board. The Board was established in late 2013. The paper is an extension of a series of papers recently produced and commissioned by the Resource and Environment Group. The Board replaced the Resource and Environment Group, which was a special members' interest group, and was created in recognition that resource and environment issues had the potential to impact actuaries, their clients and the work that we do.

The Resource and Environment Board has three objectives: first, to help actuaries to deal with resource and environmental issues as they increasingly affect their everyday work (such as in pricing natural catastrophe risks); second, to help develop the profession's expertise in the field – we want actuaries to become known as trusted sources of advice on questions of environmental sustainability, especially as it affects the financial sector, which in turn will lead to more opportunities for actuaries to develop their careers in this area; and, third, to serve the public interest.

In order to do this, we wanted to understand the latest thinking in the resource and environment areas most pertinent to actuarial work, and to bring it to the wider attention of the profession. To this end the resource and environment group produced two previous literature reviews and commissioned a further study into the impact of resource constraints which was led by Dr Aled Jones of Anglia Ruskin University.

The first literature review was completed in 2010. It addressed climate change in particular and incorporated a review of climate science and the potential impacts on actuarial work.

The second literature review was completed in 2011. It focussed on the central role of the energy supply and its use in the real economy. The review identified the threat of energy supply constraints in the coming decades and questioned the likely impact of those constraints.

The research on the limits to growth was commissioned by the Institute of Actuaries in order to look at broader resource constraints within the economy. The review concluded that resource constraints were likely to place a limit on future economic growth rates in the long-term but the many actors in the global economy did not consider this in their decision-making processes.

I felt it important to present a little bit of the framework that sits behind some of the work that the Resource and Environment Board and Group have been doing. The framework shown is intended to provide that context. It is drawn from the broad conceptual frameworks present in the papers that we reviewed.



We can envisage three distinct realms of activity.

The Natural Environment provides what Herman Daly calls the *ultimate means*. These *ultimate means* are the source of all raw materials used to allow the satisfaction of all human needs and desires.

The Real Economy represents the physical provision of goods and services with the sole purpose of meeting these human needs and desires.

Finally, the Financial Economy can be viewed as a socially agreed system of rules and conventions by which the goods and services produced in the Real Economy are allocated to individuals.

As actuaries, we spend the majority of our time considering issues within the sphere of the Financial Economy. However, it is important to recognise that the value of the things in the Financial Economy is derived entirely from their ability to exert a claim on the wealth produced in the Real Economy, that is, real goods and services.

To make this point most clearly, it is easy to see that money has no value if there is nothing for which it can be exchanged, just as a share certificate in a failed business has no value. In turn, we can then note that the Real Economy depends entirely on the Natural Environment for its raw materials and natural support systems. It is, in effect, a sub-system of nature. E. F. Schumacher starkly points out our dependence on the Natural Environment when he says that “man sometimes talks of a battle with nature, forgetting that if he won the battle, he would find himself on the losing side”.

It is relatively easy to see how resource constraints can impinge on the Real Economy. Constraints caused by the Natural Environment produce a corresponding scarcity in the Real Economy, which may result in the production of fewer goods and services or changes to the nature of goods and services demanded.

Take, for example, the shortage of hard disc drives following flooding in Thailand in 2011 or the recessionary impact of higher energy prices, particularly on energy-intensive industries.

However, it is perhaps less easy to understand the linkages between the Real Economy and the Financial Economy which are most directly relevant to actuaries wishing to assess the impact of real-world issues on their work.

For this reason, we wish to better understand the transmission mechanisms between the Real Economy and the Financial Economy, and also to understand the likely impact on sustainability of the way that financial institutions operate.

As Professor Werner will shortly cover the detail of the review, I will limit my comments to those conclusions the authors thought likely to be of most interest to actuaries.

First, the review's selection criteria was applied to a large academic universe. Given this, there appears to be a surprising absence of research on the chosen topic within top-rated academic journals. In particular, there appears to be an absence of consideration of what we believe to be critical elements of the institutional framework of our system.

Banks, for example, were rarely identified explicitly, and when they were there was no reference to their function in creating the money supply. This is important because the money supply, when it circulates in the Real Economy, is closely related to the price of, and demand for, real goods and services, and when it circulates in the financial economy it is related to asset prices and returns to asset owners.

Further, as the recent financial crisis has shown, it appears that the financial system promotes instability in the Real Economy through positive feedback mechanisms in the Financial Economy and, also, that the price mechanism of the Financial Economy may be ineffective in preventing depletion and damage to the Natural Environment via the activities of the Real Economy.

Given the importance to actuaries of the long-term stability of asset prices and investment returns, the nominal prices of goods and services and the continued ability of the natural systems to support the provision of real goods and services, we were disappointed by the omission of this institutional framework in the literature reviewed.

While the explicit role of the Financial Economy was broadly absent, other areas with particular relevance to actuaries were discussed at length. First, gross domestic product (GDP), and its limitation as a measure of economic performance, frequently arose. It is notable, due to its role in long-term forecasts of investment returns. Amongst other significant faults, GDP does not differentiate between an income and the depletion of natural capital in its calculation. This is analogous to reporting the liquidation of an asset on a business's balance sheet as additional income.

Proper accounting measures recognise a lower level of income in the income statement supplemented by a reduction in the net asset value of the business. A consequence of this may be the overstatement at the level and growth rate of national income.

The ongoing depletion of natural capital was covered in detail in the preceding literature reviews and work commissioned from Anglia Ruskin University. A valid concern is that this depletion will

result in the reduction of the Natural Environment's ability to provide a sustainable flow of natural income to the Real Economy, consequently reducing the flow of wealth we are able to sustainably produce.

Again, using our analogy of financial statements, looking only at the income statement ignores the state of the company's balance sheet. If, over time, the company's productive asset base is liquidated and consumed, the asset liquidation reduces the ability of the company to generate a sustainable income into the future. Without corrective action, it will diminish and ultimately disappear.

Consequently, we may find that a sustainable level of properly measured GDP growth, if such a thing is achievable, would be expected to lead to lower investment return forecasts, and thus increase the present value of future liabilities.

Further work on GDP as a tool for actuaries and other participants in the financial economy is therefore important.

The papers covered in the review also raise the potential need for a transition to a steady state or even de-growth economy, although there is no detailed discussion on the mechanisms through which this might impact the Financial Economy.

To the extent that our financial system may be dependent on growth to continue to function normally, there is a potential exposure to discontinuities in relation to asset prices and investment returns.

Finally, the perennial question of the use of discount rates was also brought up in conjunction with how they are used in capital allocation decisions. In the context of discounted cash flow methodologies, the far future is given little or no value. Additionally, only those items that can sensibly be given financial value can enter the analysis. This additional condition is critical to bear in mind. Values put on goods and services do not reflect any absolute measure of value but instead reflect society's relative ranking of those items.

In fact, some things are arguably outside the realm of the measure of price. This is well illustrated in an anecdote relating to the Second World War. Our Armed Forces were dependent on the rubber produced in British territories in the Far East. The high command ordered that rubber be stockpiled to ensure that a supply can be maintained if we were to lose the territories to the Japanese.

According to the anecdote, the stockpile was attacked and burnt to the ground. When the disaster was being discussed, the commander was informed that all was not lost, however: the stockpile was insured.

Clearly, no amount of financial insurance can compensate for the loss of a mission-critical real-world resource. How can you attach a financial value to something that is irreplaceable?

So why is this relevant to the topic of discount rates? Without a better understanding, our use of discounted cash flow frameworks may include the inadvertent attribution of values to real-world inputs that, like our rubber stockpile, cannot realistically be valued. The outcome of any decisions driven by such methodologies may have potential impacts to the long-term health of the Natural Environment which may impact the sustainability of the Real Economy and thus, by extension, the Financial Economy.

Consequently, the financialisation of the natural environment and the extension of the price mechanism to realms where it does not belong need to be considered, and, where relevant, explicitly addressed in the use of analytical frameworks.

To conclude, the authors believe that sustainability considerations and resource constraints are real issues facing our global society today.

The conceptual frameworks currently used in the Financial Economy appear inadequate to deal with these emerging issues and indeed their inadvertent misuse may contribute to the unsustainable use of scarce natural resources.

There is a risk that resource depletion and pollution will have an adverse impact on the natural systems on which we depend. This in turn may affect the Real Economy of goods and services and the sustainable flow of physical imports that can be drawn from and returned to the natural environment.

Finally, there may be consequential impacts on the Financial Economy. Actuarial best practice needs to find ways properly to incorporate these neutral impacts. Given our role in long-term financial planning, we need, as a profession, to understand them in order to meet our objectives of providing sound advice to our clients and serving the public interest.

Our review of the literature uncovered few papers that met our search criteria. The papers that were relevant were not sufficient to address the concerns that I have outlined. Given the importance of these questions, we intend to commission further research in order to seek a deeper understanding and to present it in a way which is relevant to actuaries.

The Chairman: Professor Richard Werner graduated in international and development economics from the London School of Economics and entered the graduate programme in economics at Oxford University. Subsequently he taught in Japan, and actually topped the best seller list there with his book “Princes of the Yen”.

Wikipedia also says that he coined the phrase “quantitative easing”.

He has been at the University of Southampton since 2004, where he is the director of international development and was founding director of the centre for banking, finance and sustainable development.

Prof R. Werner: I have entitled this presentation: “Banking and the Destruction of Nature”, which might initially sound a little drastic. However, Hugh McNeill has just given such a brilliant summary and analysis of the state of the art of our review and key implications and directions for research that I think this headline does not sound quite as outrageous as it may have appeared, initially, to those who had not really thought about this topic.

It is an important opportunity to speak to you. One sentence in the literature review is as follows: “of all the professionals in the financial services, only actuaries advise on events far enough into the future to be seriously concerned by the long-term challenge these risks concerning environmental resource depletion, the financial sector role, pose to the sustainability of our clients’ objectives”.

Hugh has already pointed towards the need for more research, but what follows, as a next step, is need for reform. I should also mention some concrete points of action: what can actuaries actually do?

Some brief results: the results can be surprising to those who have not looked at what the academics have been doing. Why is that? It turns out there are particular, concrete problems with conventional approaches which have been applied. In turn this gives direction for future research, and the role of the actuarial profession, which will possibly turn out to be the crucial catalyst for change.

The question that we posed, as some of you will have seen, is: what is the state of research concerning the question of the link between the financial banking monetary sector on the one hand and the environment, resource constraints and sustainability on the other?

It was very important to do this work systematically, and to start top down with what is considered to be the leading platform for cutting edge research. We used the Association for Business Schools' journal "Quality Guide" which is used at all the business schools in the United Kingdom to shape academic research.

As researchers, we are being told it is only worth your while if you can publish in the top-ranked journals. It is a concrete list of crucial importance to researchers in the field. We chose the top-ranked (four star/three star) journals, in the relevant disciplines: economics; finance; and the social sciences.

That gave us quite a large universe with over 120 journals and over 350,000 articles over a time period. Some of the articles were much older than three decades. The bulk were in the last three to four decades.

As you heard from Hugh, very, very few papers were concerned with the fundamental question. Those that do address that question in some way focus on particular aspects which are also important: the discount factor; the role of interest rates; the limitations of GDP as a measure of economic activity; or some other, quite narrow, issues. None model the banking sector or address central features of the banking sector.

The reason for that is fourfold.

Number one is the methodology. The approach that is dominant, driving the research published in leading journals, is the deductive or hypothetical deductive approach. Sadly, this is the reality of economic models. That approach is clearly one of the reasons.

Second, based on the particular axioms and assumptions posed in this theoretical dream world, the role of equilibrium is clearly over emphasised, and the reality of likely pervasive disequilibrium is entirely ignored.

Third, as I mentioned, banks are not modelled, and not recognised as being more than financial intermediaries but also something much more pivotal and crucial; namely, the creators and allocators of the money supply. Therefore, through their decisions, they reshape the economic landscape in a very short time period.

Fourth, growth itself and development; economic performance.

Physicists can explain to us very quickly that there is no growth, just a transformation of energy. Of course the law of entropy ensures that things deteriorate. That has implications for economic accounting, and also our economic decision-making within the institutions we have designed.

So, research is needed that addresses at least these four issues – of course there are more. It should be reality-based, inductive, empirically focussed, and display common sense in the natural sciences. There is no room for unrealistic but result-critical assumptions. Unfortunately, that is how economic and finance models currently look.

The reality of no growth needs to be recognised, which means that we should not just be driven by fairly arbitrary concepts such as GDP, but the nature of physical reality needs to be remembered. Quality of life, standard of living, biological and environmental balance, and so on, would appear to be more useful concepts.

Without the string of assumptions, we will not have equilibrium and therefore we have to recognise, and research has to recognise, that it is likely all markets are almost always rationed. That creates very different types of economic models and analysis. Particularly with rationing you suddenly have power if you want a form of politics entering the equation because the short side has the power to choose with whom to deal. That is actually the reality if you are not in these dream world models. It is most obvious in the market for money, where the demand outstrips the supply and the short side is the supply: rationing, allocating and making crucial decisions on how resources are deployed and mobilised.

Also, banks need to be recognised as what they are: agents of change for the better or for worse. Of course that has to inform regulation and policy.

Decisions by banks can shape the economic landscape in the most rudimentary fashion. Banks create the purchasing power that is necessary to engage in economic transactions that are market-based. Therefore when this purchasing power is created and allocated for particular transactions, you will see more of them and therefore, put simply, if banks lend more for financial asset transactions, more of them will take place. More money is being injected which is merely created by the banks in inter-asset markets, and asset prices rise or fall depending on the collective decision of banks.

That can be very destructive, as we have seen. If, on the other hand, banks create credit for consumption, you will see consumer price inflation.

The reverse happens if credit falls. If banks create credit for productive purposes, when the newly created money is used for the production of goods and services, it is productive. But you must, of course, include proper allowance for the environmental impact. It cannot be productive if it is environmentally destructive.

Then you will see, within the current framework, stable growth without inflation.

Even within the current framework there is a lot of room for improvement. There are broader issues. There is the topic of usury, also known as interest. Economics and economists would like you to believe that interest is an important policy variable, which is usually a central variable in various models. We do not debate whether we need interest or whether interest should even be allowed. Yet, it is a recent thing. Until 300 years ago, interest was banned in the United Kingdom, in Europe and in most countries in the world. Obviously, the system did work without interest.

But, is it not needed in our modern, sophisticated system? Actually, it is just a transfer payment. It is a fee that has a particular calculation. But that is all it is. It is a fee – a transfer from one group to another, usually from the many to the few.

But studying this issue – and of course much more work is needed – you do see that this may be what is tying the various problems together. The strange use of GDP may be explained by the usefulness of GDP when you are operating in a bank credit creation and usury-based economic system. Then GDP tells you the ability to pay the debt which is the source of the money supply.

Recognising this allows us to come up with alternative schemes which are much more sustainable because the present one seems to serve a particular purpose. In a debt-based monetary system we need that nominal growth. That does impose a bias towards the constant depletion of resources. Then it is handy that we are not showing that depletion and destruction so that we can continue with the same process.

This broader theme of the role of the financial system, the money creation, the banking system, usury, and the destruction of nature, is actually the theme of a book that was published in the 1980s by Professor Binswanger, who is an economist. He started out very mainstream in Switzerland. He set up an institute for research on economics and sustainability. He was clearly one of the early ones to do this. His work is not very widely known in the English language. It is mostly published in German in Switzerland.

He uncovered in his research an even older piece of writing by the German poet and philosopher and former finance minister, who has had lots of hats: Johannes Wolfgang von Goethe. Faust II, the second part of the drama, it turns out, thanks to Professor Binswanger's landmark research, is almost entirely about the role of the monetary system in giving the wrong incentives towards ever-stronger growth and the destruction of nature.

This book is being republished in English in the coming weeks. Lord Turner has kindly agreed to write one of the forewords to this book. It is really on the topic that we are addressing this evening and which the literature review has been addressing.

So, what can be done? There are two areas where actuaries can help and become involved. First, we need action within the current system to start work on incremental improvement. The easiest element is to ensure that the banks we have and which dominate the banking system are banks which mainly create credit and money for productive purposes, including environmentally productive purposes. The privilege to create and allocate money is only justified when it is serving the public good.

Public benefit banks do exist. It turns out that in Germany 70% of banking is not-for-profit. There are 1,700 cooperative banks, savings banks or community banks. They have delivered much more funding for environmental projects, for alternative, sustainable energy sources. Such banks routinely lend to those projects. They lend longer term. There is a lower yield but it is a steady yield. In the United Kingdom this has been considered unattractive, too long-term, with yields which are too low, so there has been far less funding.

Lending for small and medium-sized enterprises (SMEs) is another route to sustainability. There has never been a banking crisis caused by too much lending to SMEs, because they tend to be much more active in the real economy rather than in financial speculation.

One of the projects in which I am involved is creating and launching the Hampshire Community Bank as a prototype, providing a blueprint to be copied and then multiplied across the United Kingdom. We have raised money for capital from the local authorities and universities in Hampshire and we are also at the same time receiving many requests from other stakeholders in other parts of the country. So, we hope that this will take off in the coming year or two.

But, of course, support is needed. I think many of the insurance companies have corporate social responsibility departments. This bank does not quite yet have its bank authorisation but has started SME lending, by the way, thanks to support from the government.

The other action point, as I mentioned, is more research. The literature review is really the first stage, the necessary and important but first stage of a research programme. What we have now demonstrated is that the so-called leading journals, and the researchers publishing the leading journals, have failed dismally to cover this topic, even just to address the question, let alone come up with solutions.

The literature review itself is therefore already very important to demonstrate this position. I am grateful to the actuarial profession for putting together the resources to support this activity. I hope you can also encourage and support the next step which has to be supporting research about the questions raised.

What are these core issues? Some of the things that Hugh and I have mentioned are things that require much more work. That needs to be done meticulously, based on empirical fact, with econometric statistical analysis to back it up.

The Chairman: The next speaker is Lord Adair Turner, Baron Turner of Ecchinswell. He has combined careers in business, public policy, and academia. He became chairman of the UK Financial Services Authority as the financial crisis broke in September 2008.

I was chair of the National Association of Pension Funds then. It felt pretty heavy duty to me; but he was really at the centre of the maelstrom and played a leading role in the redesign of the global banking and shadow banking regulation as chairman of the International Financial Stability Board's Major Policy Committee. He became Senior Fellow of the Institute of the New Economic Thinking in 2013, and chairman of the governing body in April of this year. He is also a senior fellow at the Centre for Financial Studies in Frankfurt.

But to me all this is unimportant. What is really important to me is the fact that he headed the Pensions Commission back in 2005 and redesigned the UK pensions structure with auto-enrolment and NEST – it would not exist without him.

Lord Turner of Ecchinswell: The last time I was here I was presenting some of the Pension Commission conclusions in the course of 2005–2006. As Chris (Hitchen) says, I feel pretty good that the conclusions, the analysis, that we did at that time has stood the test of time. It is a great pleasure to be responding to the very thoughtful document about sustainability and the financial system, and a particular pleasure to be following Richard Werner.

Richard is an economist whom I really got to know about 4 or 5 years ago when I got hold of not “Princes of the Yen”, but another book called “New Paradigm in Macro-Economics”, which was a real eye-opener to me. Richard, unlike a lot of mainstream monetary modern economists, had really

thought deeply about what was the nature of money and credit, and had informed that with a deep historical understanding of the origins of banking and credit. I think you really need to do that to understand some of the crucial things that go on in economies.

This session is about the environment and finance. For 4 years there were two different halves of my brain dealing with the environment and finance. I was, from 2008 to 2013, chairman of the UK Financial Services Authority. As Chris said, I took on that task just 5 days after Lehman Brothers collapsed and 11 days before we essentially nationalised part of the UK banking system. It was like being appointed chairman of the Titanic after you have hit the iceberg but before you have actually sunk.

But at the same time I was also, from 2008, chair of the UK Committee on Climate Change, which is the body charged, as an independent authority, with driving down carbon emissions to achieve an 80% reduction by 2050, and being the custodians of the remarkable long-term policy framework which is set out in the Climate Change Act 2006.

Throughout that time I was thinking about the problems of financial instability and the problems of how we achieve sustainability in the specific area of climate change.

For most of that time I did not actually connect all that much the two sides of my brain. On the financial side there originally was not much time to think too much about the long-term. We were basically concentrating on making sure that another bank did not go bankrupt week to week. It was very much fire fighting and then building a more stable system.

But increasingly I have thought about the links between what is wrong with the financial system and what are the implications of that for the environment.

So what I would like to do this evening is just begin with some comments about what is problematic about the financial system in general. Even if we did not have a problem of the natural environment, and we just had a problem of the relationship between the financial system and the real economy, then what extra complications come in when we realise that we have what economists would call the major “externality” of climate change – a problem which free markets will not themselves take into account.

So, to begin, then: why is finance different? I think that the crucial thing to realise is that finance is different and that financial markets are different. The propositions for, broadly speaking, having a free-market economy, and not a planned economy, are propositions that go back, for instance, to the great work of Friedrich Hayek about the way that the price system works as an information aggregating and distributing system and a generating system which is far more powerful than any planned economy system can ever be.

Then there are propositions in economic theory that tell us that if we give people the right to compete, and if we give them the incentives to compete, and if we allow the existence of as many contracts as possible, what is called complete markets, then you can illustrate that we will tend to achieve what is called a Pareto Optimal – it will not necessarily be good in distributional terms, but it will be efficient.

That is the body of Hayekian theory about the price structure, price system and information, and the work of general equilibrium, competitive equilibrium theory, the work of Kenneth Arrow and Gerard Debreu, which is the absolute base load of the intellectual case for markets rather than planned economies.

In fact, in the real world every single market you can think about is actually highly imperfect. There are no perfect markets. They are all imperfect in their own particular way.

There is a wonderful phrase from Paul Krugman, which goes: “all perfect markets are perfect in the same way all imperfect markets are imperfect in their own particular way”. A lovely little twist, some of you may remember, on the opening lines of *Anna Karenina* that all happy families are happy in the same way all unhappy families are unhappy in their own particular way. All markets are imperfect, and all are imperfect in a very particular way.

But it turns out that there are many markets where that does not undermine the fundamental case for a fundamentally free-market approach. The market for restaurants is imperfect. The signalling processes are imperfect. There can be economies of scale effects that give people a dominant power. But, broadly speaking, nobody can think of a better way to organise the restaurant market than to say let us just leave it completely to the free market. There will be a bunch of entrepreneurs. Some will win; some will lose. And if you do not believe that, none of you had the joy of visiting a restaurant behind the Iron Curtain before 1990. It works.

What is interesting about finance is that markets work much less well. There is a set of reasons why they work much less well. The core of it, which I think is fascinating for actuaries, is that financial markets are attempting to connect the present to the future under conditions of inherent uncertainty as to what the future will bring.

What that means is that all financial markets are subject to degrees of inefficiency and instability which are far more serious problems than the problems in the market for restaurants or the market for bananas or the market for cars.

Essentially, that process of thinking out what the price of a financial instrument should be is an essentially much more difficult process, and a much more uncertain process than the process of arriving at a market clearing price for bananas or iPads or anything else which is traded in the market for current goods and services.

It turns out that when we try to generate the price of something which is a flow of cash flows out into the future, we always get instability because, contrary to the assumptions of the rational expectation hypothesis and the efficient market hypothesis, human beings are not entirely rational. They have part-rational, part-irrational bits, part-emotional bits, of their brain. They operate, often, in herd effect. They are influenced by what other people believe in what George Soros calls reflexive processes.

Out of that whole body of thought you get a variety of reasons whereby stock markets, for instance, or foreign exchange markets, are subject to surges of national exuberance and despair which are complete contradictions of the efficient market hypothesis.

Nobody can really explain why the major stock markets in the world – let us take the New York stock exchange – fell by 23% between the opening and the closing bell on that day. I forget precisely which day it was. It was about 23 October 1987. The Black Monday event.

These things are inexplicable in terms of a rational theory. Indeed, if you were to ask why did the NASDAQ go from 1,000 in 1995 to 5,300 or so in April 2000, and then back down to 1,500

in 2003, you cannot explain it in terms of a rational set of discounted values of a reasonable assessment of the future cash flows which would derive from that market.

So we basically deal in financial markets in a way that we do not deal with in the market for current goods and services with some fundamental challenges to our basic argument for the free market rather than the planned economy.

But, actually, the crucial point is that is not at all conclusive that we should get rid of free financial markets because we are not comparing free financial markets with a perfect planner. We are comparing free financial markets with the nearest you can get to a perfect planner and you cannot get very close to a perfect planner at all.

It turns out that the chaotic, irrational, sometimes unstable, financial markets that we have are still, on the whole, better ways to allocate capital than handing it over to planned systems. Yes, the movement of the NASDAQ up and down was irrational. A whole load of kids went and set up internet companies that had not a prayer of surviving. A lot of people lost money. But at the end of the day, we also had the internet; we had Apple; we had Google; we had Yahoo, *et cetera*.

There was a process of creative destruction. It was not at all what our smooth equilibrium models of economics describe: it was what Schumpeter described as creative destruction. But it was still, at the end of the day, a more positive system than we would have had if we simply relied on the planned economy, which is why America, the American capital markets, created the internet and not the Soviet planning system.

So, financial systems are unstable. They are inefficient. They imperfectly help us understand how we should value future cash flows. But as long as they do not produce too much instability, then we can probably, broadly speaking, have a free-market approach.

But, there are particular bits of the financial markets where that is not true and where, if you simply leave it to an entirely free-market approach, you will produce such instability that eventually you will blow up the economy, as we did in 2008.

Those bits of the economy are fundamentally those which relate to debt contracts rather than to equity contracts, and those which relate, in particular, to the role of banks in creating debt contracts and in creating credit, money and purchasing power.

It turns out that there is something about debt contracts which fools us. When we invest in equity, we know that it can go up tomorrow or go down because over the last 5 days it went up and down. With debt contracts we fool ourselves for a time that we have a risk-free contract, that it has not defaulted any time over the last 5 years, and then we suddenly panic when we realise that what we thought was a risk-free contract, has a tail of the distribution which can impose a loss on us.

So debt contracts bring a rigidity, a jump to defaultness, a lack of smooth adjustment into the economy. And the more debt contracts we have, the more highly leveraged the economy, the less stable it tends to be.

But the really big problem is banks. If you pick up an undergraduate economics textbook, and read the bit which describes banks, it will fundamentally tend to say the following. It will say: "Banks take

money from savers and they lend it to borrowers”. They will tend to assume that banks take money from households and lend money to businesses. Then it will explain how, in lending money to businesses, the banks allocate the capital between alternative capital investment projects.

That is what we teach generation after generation of undergraduate economists. Unfortunately, as a description of what banks do in the real world – and this is where the work of Richard Werner has been brilliantly informative – this is utterly mythological. Banks do not take pre-existing money and lend it on, they create credit money and purchasing power which did not previously exist.

That is a fundamental insight which was described by lots of early 20th-century economists such as Knut Wicksell, Friedrich Hayek, Joseph Schumpeter and the Keynes of “A Treatise on Money” even more than of the general theory. Yet it is an insight which broadly disappeared from mainstream macro-economics after about 1970. But it is fundamental.

But it is also fundamental that the majority of what banks lend money to when they create that money, credit and purchasing power is not new capital investment. If you look at all the bank lending in the United Kingdom, how much of it really was allocated to a new capital investment project? My calculation is about 15%. The other 85% either funds consumption, that is, impatient consumers or simply poor consumers, or it funds the purchase of real estate, and primarily the purchase of real estate that already exists, the value of which primarily resides in the locationally specific land on which the real estate sits rather than in the construction value of the house itself.

The relationship between the ability of banks to create credit money and purchasing power and the inelastic supply of locationally desirable land, is not just part of the story of financial instability in the modern world, it is, again and again, the whole of the story. It is why we had the crisis of 1990 in Japan and the long post-crisis recession. It is why the Scandinavian banking system blew up in the early 1990s and why Massachusetts went crazy in the late 1980s, Texas in the early 1980s, and it is why, yet again, in 2008 we managed to blow up the world economy with serious effects.

It is that relationship between the inherent inefficiency and instability of all financial markets when it expresses itself in the ability of banks to create credit money and purchasing power and to pile that up against the inelastic supply of desirable locationally specific land. That is why we screw up our economies and end up with the great recession after 2008 and the very slow and weak recovery faced with the debt overhang with which we are struggling.

So that is the problem. The other problem that we have is that all the tools that we thought would make the banking and credit creation system more stable actually tended to make it less stable. We were very proud before the crisis that we had these technologies called securitisation for taking credit off bank balance sheets and distributing it.

You may remember that the phrase was that “by slicing and dicing risk we would be able to distribute it into the hands of those best able to absorb the risk”. That actually is a quotation, almost verbatim, from the International Monetary Fund (IMF) Global Financial Stability Review of April 2006. That review goes on to say that this increased resilience of the system may be seen in the lower probability of major bank failure and the increased consistency of the supply of credit.

I fear that the person who actually wrote those words is somewhere tied up in the dungeons of the IMF and is no longer allowed out to see the light of day. But that was the pre-crisis orthodoxy.

We had securitisation. We had turned bank credit into a specific traded security, and once we had done that we could also use techniques like mark to market to say what the value right now should be, then we could use models, like value at risk models, to tell us how much capital we should hold against that mark to market value of the security we were holding.

Actually, it turns out that these techniques, which we thought would make the system more stable, made it more unstable because mark to market accounting took the instability of the credit and asset price cycle and increased its visibility and therefore increased the power of the herd effects to which human beings are subject.

Value at risk models, which attempted to derive a probability distribution of future events from the observation of recent past events, had the effect of massively increasing the pro-cyclicality of the banking system.

The more that people were irrationally exuberant today, the more liquidity there was in the market today, the less volatility of prices there was today, the more that our value at risk models told us we could do more trading, so we did more trading and more trading until we had the point at which it cracked and then we went into the downswing.

There is a wonderful analogy by this in the work of Hyon Shin, a very fine economist, who has just moved from Princeton University to the Bank of International Settlements, who points out the huge and vital difference between what makes sense from one individual in a system and the impact of that on the system's stability.

The analogy he draws is the Millennium Bridge. Remember when the Millennium Bridge was first built it had a wobble, and the wobble derived from the following fact. There was a very, very slight natural wobble produced by the wind. If you became aware of that slight natural wobble produced by the wind, you had a tendency to move your foot to the right or to the left.

But if everybody moved their foot simultaneously to the right or the left, the wobble increased. What is interesting is that in order to be the person least likely to fall over, you have to be the person most likely to shift your weight. But it is the people most likely to shift their weight who actually contribute most of all to the instability of the whole system.

Actually, the people who were most adept at applying the mark to market models and the value at risk models were the relative survivors of the carnage of 2007 and 2008, but they were contributing as much to the systemic problem as those who were complete idiots and did not manage to survive at all.

There is a fundamental difference in economics and in finance between the way that the system works and what is good for the system versus what is good for the individual within the system.

That, I think, has some crucial issues in relation to financial regulation, in relation to some areas which ought to be important for actuaries, issues like pensions and insurance companies, because I think that there is a great danger that if we over-simplistically apply mark to market approaches and value at risk approaches to those natural long-term holders of long-term assets, we can actually undermine their ability to be the natural countervailing power against the pro-cyclicality and the short termism of liquid financial markets and banks. I have a fear that

Solvency II does precisely that in its impact on the behaviour of insurance companies and pension funds.

So, what we have in the relationship between finance and the real economy is a whole set of reasons why we cannot simply assume that if we leave it purely to free markets, it will produce optimal results in the way that we can assume when we approach the market for restaurants, the market for hotels, the market for bananas or whatever.

But what does that then tell us about the environment? I will use the example of climate change, to explore the relationship between the real economy and the natural economy?

I think that we are aware – I think we should be aware – that we face what economists call an externality. We face the fact that we all put carbon emissions up into the atmosphere but we do not face the cost of that because the cost is pooled and the cost is long-term. It is a very, very extreme example of an externality effect.

The classic response of an economist to an externality is to say let us price the externality, and the most obvious thing might seem to be simply to set a carbon price, to say: “Okay, if we set a price whereby everybody who emits carbon now or in the future faces a cost of carbon”, then the market will work. So I have my magic, single answer. I have noticed an externality, and I now price the carbon and the externality is dealt with.

I certainly agree that that is a very important part of our policy response to the problems of climate change.

But I think the fundamental problem – and this is something that we became very aware of on the climate change committee when we were thinking about the appropriate regulation of the electricity market – is that in an environment where financial markets link the present to the future under conditions of uncertainty and imperfect thinking and herd effects, simply saying “I am going to solve this problem by a product market externality price” is not adequate. It is not adequate, first of all, because you will never secure enough agreement and clarity on what should be the price.

The perfect answer is that an all-seeing, clever group of politicians at the global government level say: “The price of carbon ought now to be €20, and by 2030 it is going to be the €35, and by 2050 it is going to be €70”, and it is published, and it is believed, and it is going to be universally applied, and everybody who is making their investment decision today takes that into account in their investment decision and – hey presto! – we end up on an optimal least cost path of carbon emission reductions.

Problem 1 is we simply cannot test that degree of agreement. Problem 2 is that even if you did obtain agreement, there would be varying degrees of belief of how much it would stick, and then how much one ought to take into account. When you think about the investments that have to be made to deal with climate change, many of them are very long-term.

What we realised on the climate change commission is that if you tried to pull through optimal decisions by saying: “Right, we are going to tell people there is a carbon price in the future”, and you try to get people to make the decision between renewable energy and, say, gas energy investment now, what you were doing was piling uncertain probability distributions on top of other uncertainty probability distributions.

The decision on whether to invest in a wind farm or in gas, seen in terms of the product revenues in 2030, depends on the price of electricity hour by hour in 2030. It depends, then, on the carbon price in 2030. Both of those have degrees of uncertainty around them.

It is of the nature of renewable energy projects, and many of the other things that we have to do which are good for the environment, that they require very high short-term capital investment and then zero marginal cost thereafter.

Once you realise that, you realise that the crucial point of intervention might not be through the product market but through the cost of capital market, or through regulatory intervention.

That then links very importantly, and finally, to some of the issues that Hugh talked about, such as issues of the discount rate.

If you discount the far future at the sort of rates of return that private sector participants believe they are going to obtain, or even at very low estimates of that, you will do nothing about climate change whatsoever.

Here is a little calculation. Suppose you believe that the appropriate real discount rate to try to deal as best as possible with far future costs and benefits of climate change is 4%, because you think you can get a real return elsewhere in the market place of 4%. Suppose you believe that unless we take action, the entire human race will be utterly destroyed in 2150. That means your grandchildren's grandchildren. And suppose you believe that to stop that you have to sacrifice 6% of income each year.

At 4% real, you would not do it. If it is 4% real, everything which we try to measure in human welfare from 2151 onwards for ever and ever is not worth more than 6% of GDP today.

That does not seem to me a very sensible way of making such a decision. But once we realise that we are dealing with very long-term problems, we have to find other ways of making the decision.

This, I think, poses very major problems. In essence, we have in that relationship between finance and the real economy a set of major problems that even if we did not have a problem of sustainability we could not necessarily rely on free financial markets to produce optimal results. But when we introduce the externalities of the environment and climate change, we can rely on it even less. And that is why I think it is very valuable that you think carefully about what the link is between sustainability and the financial system, and what the role of actuaries is in thinking about that topic.

The Chairman: May I turn briefly to Nico Aspinall, who is head of DC at Towers Watson? He is the incoming chair for the Board. I suppose what we have been hearing tonight is that much more needs to be done to bring sustainability research into actuarial science. I was wondering what you thought the next steps might be.

Mr N. Aspinall, F.I.A.: Fundamentally, the review highlights a number of issues.

The three that we have raised are symptomatic of a wider understanding of economics in the actuarial profession. We went to the academic research to ask if we had missed something. Is it too long since we last went back to academia and asked what economic models look like?

On the one hand, the bad news is no, we really have not missed anything. There is a handful of papers. They have not built a consensus, raising some very interesting thoughts. But for me there is a huge opportunity for the actuarial profession to be in the vanguard and stimulate the financial economy and understanding of these issues, and take them back home to our clients to make sure that capital allocation decisions can be made more appropriately.

We formed the Resource and Environment Board in the beginning of 2014. I will be taking over the chairmanship of it in September 2015.

I think the points highlighted are, as I said, part of a broad series of topics. They are all controversial. They all have the ability to challenge actuaries in the way that we work in our day jobs.

We will be on the front foot and saying that this is where actuaries are coming into the 21st century, kicking and screaming, and really demanding that we become cleverer for our clients, for the fiduciaries and for institutional investment across the economy.

In short, the Resource and Environment Board needs you. We need you to staff those working parties and to help us generate quick wins, and have quick ideas which will stimulate the actuarial profession.

There are a huge number of opportunities. When we talk to climate scientists they are fascinated by the actuarial mindset. They really think that our attitude to risk is something hugely compelling.

Mr M. G. White, F.I.A.: If you want companies to be run more prudently and more for the long-term, and you want to discourage the idea that a high rate of return on equity is the one thing to aim for, it is worth considering whether there is an in-built feature in the financial environment that penalises the equity-rich or the shareholders of equity-rich institutions.

I think that there are two such features. One, which everyone understands fully, even if governments are slow to tackle it, is the fact that debt interest is tax deductible, thus making the cost of finance through debt cheaper than through equity.

But I think that there is a further measure. It is very important. It is the fact that financial institutions such as banks pay tax on unrealised capital gains. In consequence, they are an inefficient place to park equity capital that holds risk accepting and patient wealth.

Lord Turner: They have to pay tax on unrealised capital gains because they count as profit. Quite clearly we now know, in retrospect, that at the end of 2007 people were booking a set of mark to market profits on various trading portfolios. Not only were they telling their shareholders they had made their profit, not only were they putting at least some of that to the taxpayer, but they were paying out large cash bonuses to the traders who had put on those positions long before it was clear whether that was a sensible thing to have done in the long-term.

I had not thought about the tax side of it. What we have tried to do is attack the bonus side of it by saying you should not get bonuses paid out of unrealised capital gains at an early stage in the process. I guess you could also think about the tax aspect.

On the first one, the tax deductibility of interest, it is something where almost all economists would, in theory, say it would be good for us to reduce the tax favouritism in favour of debt. My basic belief is that

there are some naturally arising tendencies for free financial markets to produce too much debt, and that those would arise even without a tax bias. But we have essentially taken a large can of gasoline and chucked it on the fires to make it worse by having the tax bias in favour of debt.

I would hold out almost no expectation whatsoever that we are going to be able to generate the global agreement and coordination sufficient to deal with that large bias in our financial system.

The Chairman: You might have been putting forward an extra reason why pension funds and insurance companies are becoming shadow banks, though.

Mr P. D. G. Tompkins, F.I.A.: One of the things that happens when we look at systemic risks is that we address the question of regulating more. So regulation after 2008 was a big issue as we changed regulations and capital requirements and so on. Inevitably, this always happens after a problem. And we see is a ratchet effect. We do not then later go back and look at what we are doing, and whether we are doing things sensibly.

I just wonder whether there is something to look at in terms of the cost of regulation. Regulation costs us. There are plenty of regulations, like money-laundering, which are a complete waste of money, but we do it because we never un-regulate; and we do not tell politicians to get on with deregulation because we know what happens when a politician decides to deregulate.

There is an issue about the cost of regulation, and why we do not look at and manage our regulatory system in the periods of calm. We always do it after a period of crisis. I wonder whether there is academic research looking at the way we treat regulation.

The Chairman: Is that something you came across in your review of the literature?

Mr Aspinall: It was not a specific research topic. Maybe I can offer some thoughts on the topic. There are natural systems which are self-regulating, and there are analogies in ecology which are very interesting to us. The concepts of regulation are the opposite of what nature does when it tries to be stable in its ecological systems.

There is a certain question which says if we allow entities in our society to be rapacious, we ought to look across at ecology and see the kind of results that you obtain.

It is not entirely clear to me that you have stable systems or ones which are allocating capital particularly efficiently. There is an analogy there which I think will be very useful to us as well.

Dr L. M. Pryor, F.I.A.: First, just to pick up on the stock market booms and busts, and especially the DotCom boom and bust. From my own experience, the boom and bust phenomenon is a fantastic mechanism for wealth transfer from the investors to the knowledge workers. I have many, many friends who have been profitably employed for many years by loss-making companies.

To get back to the point, this idea that economists, academic economists in particular, are very limited in their outlook and are prepared to do only certain sorts of work. If they were to do work which we felt, on the basis of this discussion, was more interesting, more useful, and more productive for the rest of us, are there other social barriers to overcome? For instance, editorial boards of journals and academic referees.

It is all very well saying more research needs to be done. Maybe some of it is being done but is not being published anywhere.

Prof Werner: I think you are absolutely right. There are barriers. That was the rationale for putting a lot of effort into the literature review because we wanted to demonstrate that extraordinary limitation.

Of course, we are not talking about why this is, but first it was necessary to make the point that it is quite extraordinary how crucially important issues are being ignored. That is the foundation for then staging research that addresses the issue, but also for criticising the profession in economics and finance and its behaviour.

We still need a lot of debate about precisely how we should solve the problem. But ultimately I think there needs to be a change in the editorial policies and the very closed systems. As you know, there is a trend towards open access, open source, open journals, and so on. But there is a lack of credibility so far because money is basically handed out on the basis of the Association for Business Schools list, and other lists in related disciplines. That reinforces the narrow focus.

So, I agree that the problem exists. We are taking the first step of recognising it.

From the academic viewpoint, it has been a major frustration because the main journals simply reject your research on spurious grounds.

Mr Aspinall: We should also look at the actuarial profession, because of interdisciplinary science: it is very hard to be a specialist in a generalist area.

Part of our mantra as the Resource and Environment Board is to talk about rows and columns. A row being that we can support all of the existing practice areas, and a column being that we can create a new one.

Interdisciplinarity is an issue across-the-board. We all need to be a bit more open to outside influences.

Mr N. G. Silver, F.I.A.: Lord Turner mentions the difficulties of investing in renewable energy, with which I entirely agree, and he also mentioned that only 15% of bank lending is into that kind of useful, productive economy.

Also, if you look at institutional investors (pension funds and insurance companies), only 1% of institutional investment is on infrastructure. It is not a question of banks and institutional investors looking at renewable energy projects and thinking that they are difficult; it is a question of them not investing in the real economy at all.

Richard Werner gave an answer to what a sustainable bank would look like; but how do we move towards a different system where banks are actually lending into the kind of things that we want them to lend into, and institutional investors are actually investing in the sort of things that our economy needs?

Lord Turner: I think we have to be careful of assuming that the 85% is completely socially useless. But we have to understand what it is.

Suppose you had an economy in which we built no new houses because we have a sufficient housing stock and the population is stable. You might still want to have a house mortgage system essentially to lubricate the interchange of an existing housing stock between generations and different people moving geographically around the country and people who went up the income group during their life and people who came down.

Even if the housing market was not just primarily but entirely disconnected from any new capital investment, I still think that there is a value from a mortgage market. But I think it should be very considerably smaller than we have at the moment.

Therefore, I think there are two policies we should be applying to limit the amount of credit that is flowing into that activity. I think that we should regulate maximum loan to value or loan to income limits, not merely to limit the losses which an individual or a bank will face but in order to calm down the dynamism of the existing housing stock asset price cycle.

I think we should set capital weights for lending which attach higher value to real estate lending than will ever appear logical seen from the point of view of a private investor. The problem is that seen from the banks, it not only seems to be the case but it is the case that lending against real estate is a low-risk thing to do.

They get paid back. But the very process of encouraging people into a high level of debt and then those people, post a recession, having to cut their consumption in order to pay back that debt, is what drives the economy into a recession.

The problem of excessive housing credit in macroeconomic terms is primarily driven by those who do pay back their debt in full, not by those who default. Therefore, seen from the point of view of a banker, that lending was good lending. It was good lending privately but had a bad overall effect.

The great book on this, by the way, is a book which came out last year called “House of Debt” by Atif Mian and Amir Sufi on the US mortgage credit cycle. So I think there is a set of things that we can do to discourage the lending that we want some of, but less of.

On the other hand, we may need to create institutions where we say: “We want you just to do what the textbooks say banks do. Your licence does not allow you to go off and do mortgage lending or buy-to-let lending or commercial real estate lending. You are a bank with a licence which says you are allowed to do everything else”.

I think there are things that we can do but there have to be much stronger policy levers than we have pulled so far.

Mr N. J. Weir, F.I.A.: I am interested in the relationship between the macro and the micro. We talked a bit about localism and that sort of thing. But when you think of, say, the businessman who has done his business, he does not want zero growth or negative growth, he wants to have a successful business. Looking from the perspective of the economy as a whole we have had zero growth for quite a number of years recently but that is more by accident and it was not a particular target.

So, am I correct in thinking you have to create a structure, a framework, within which you can let people get on with it, and that structure will include things like regulation, some sort of laws in

relation to resource efficiency, sustainability, the circular economy, obviously renewable energy, and that sort of thing? Then people can get on with it and what you end up with is whatever you end up with, I suppose.

Prof Werner: I would endorse Adair's suggestions and extend them also into the area of sustainability. Basically, we can give banks incentives and also discourage them from particular types of lending. We can encourage lending for projects that are sustainable and environmentally enhancing and discourage environmentally destructive lending.

One could go as far as to tell the banks that there are some things you cannot lend for at all, so you ban them. For instance, if banks are not allowed to lend and therefore create credit and money for the transfer of ownership rights in existing assets, that is the end of the major asset bubbles and cycles, and the accelerated destruction of the environment, which is usually connected to that process in a boom period.

But then, on the positive side, you can encourage them in various ways from regulatory ratios and prudential ratios, central bank ratios, to tax advantages, so that they lend more long-term and more to small firms, in local areas.

Finally, third, we simply need to create new types of banks such as local banks. They did exist in the United Kingdom 150 years ago. There were a lot of county and country banks. Precisely because banking is profitable also on the local level, they were taken over and then merged into ever-larger institutions. That is good for the owners of the bigger and bigger banks, but there are diseconomies of scale in banking because you get more and more of the negative results of bad banking, the bigger the banks become.

Hugh quoted Schumacher. He is famous for his small is beautiful approach. There is a physical limit. Banking is ultimately about people on both sides. The big banks are trying to replace that with computers. But ultimately it is about people and therefore there is a limit to the size that is sensible and sustainable on both sides.

We have seen it all as users of bank services when you are on the phone to a call centre. It can be very different. When you have a network of dozens of community banks, you walk in and they know you and you do not have to go through the identification spiel because they recognise you when you walk in. This is possible. It has existed. It continues to exist in the United States and Germany.

So the third recommendation would be to introduce different types of banks.

Mr J. P. Ryan, F.I.A.: I am concerned at Lord Turner's approach which seems to be coming from some false premises. First of all, the perception that banks think real estate is a secure investment is simply because the models they use are mathematically flawed. Value at risk is mathematical nonsense when it comes to evaluating risk in such terms. That inevitably shows that real estate is a good risk but since you are using a flawed model to evaluate, it does not make any sense.

The other reason that markets are not working is that the whole theory of markets and efficient allocation of resources requires efficient markets which means willing buyers and willing sellers.

In the extremes, and particularly in the oligopoly of the banking market, and the very tightly regulated market we have in the United Kingdom, we do not have a proper market place. Again, discounting long-term rates of 4% and 6% is not the solution.

If you are going to discount the cash flows in uncertainty you do it at the risk-free rate because otherwise you are discounting the uncertainties at a ludicrously high rate. So you must do all your discounting at the risk-free rate and then do the comparative return that way. Then you can come to different answers.

I agree the uncertainty is so great it is very difficult to do, but one of the things that we, as a profession, can do is to get some of these points right and make sure that the mathematical models used by the bankers are much more efficient. In my view, certainly one, if not the major, cause of the banking crisis in 2007 was the fact that we left the authorities to allow banks to use Value at Risk (VaR) as a means of managing their risk.

Mr O. D. Bettis, F.I.A.: The literary review showed that there is not much research on this topic in the top-ranked journals. I wonder whether the panel have any thoughts about whether these issues are being addressed in other places by other institutions. And also what would be the most useful research topics for the actuarial profession to look at next?

Mr McNeill: Thank you for your questions and thank you for the value at risk question. I think one of the things which we have not recognised is that this literature review, like any literature review, will have its own limitations.

There were particular selection criteria which were used to select the papers that the review addressed. We did cover 255,000 papers in that review. It may well be that there are other lesser rated journals which are admirably covering these topics.

There are also people who are covering many aspects of these topics that may not have linked them with sustainability issues. So there is quite an active group of people, the post-Keynesian economists, of which there are a number of people, looking particularly at monetary flows and how money flows around the economy and the impact of that on the banking system. That is all very interesting stuff. It was not captured by our review.

A lot of work was done in the 1970s. If you read any Herman Daly, which I can recommend to people, there is a lot of conceptual background which we can build on; but again is not being brought into the current review.

I would not say that there is a lack of work entirely in this sphere. What there appears to be is a lack of work which connects the spheres of the financial economy and the natural world, with the real economy sitting in the middle.

What I should like to see is more work which really addresses how those things link, because what I have found, thinking about these topics, is the way we tend to think is atomistic. We do not think in systems. We do not think about how money flows around the system. If we come back to the point that Martin (White) raised earlier about whether there is a preferential treatment of debt versus equity in companies, at the company level that might appear to be the case.

If you look at where that money goes next, where the interest payments go, it is received by somebody in the economy and, depending on the taxation requirements of that individual, and what they have to declare on their tax return, it is taxed in some way.

When we are looking at these things, we have to look at the whole picture. If we do not look at the whole picture, we will make the same mistakes that have already been made.

The Chairman: Nico, you are a business graduate, I believe. Entropy theory was applied earlier to finance.

Mr Aspinall: Entropy for me is one of the missing pieces from our economic education and it is possibly the most controversial topic, to be honest, in economics.

We mentioned Goethe and Faust. I think Sisyphus is a better analogy for the modern economy in entropy understanding. We must keep on rolling that stone up the hill to avoid the second law of thermodynamics. I think Sisyphus is probably a better book – Goethe III I think should be Sisyphus.

Prof Werner: As we have said, the research questions that need to be addressed should, first of all, be done in a framework that is scientific, not pre-judgemental. In the latter, there are axioms and assumptions that come are designed so that you end up with a model that gives you the pre-determined result that you want, which is a thoroughly unscientific process.

Obviously, we need to approach this in an open-minded fashion which is both fact-based and empirical-based, analysing the reality of the financial sector, particularly banks, and their interaction with the environment.

There is a lot of interesting work to be done in that area. Some feel we are very close to what actuaries need for their long-term decision-making. Some of it will be of a more abstract type: all of it will be very useful and relevant in shaping this debate.

Lord Turner: I agree that VaR models are deeply flawed, but I do not agree that they are the fundamental reason why there is a harmful bias to real estate lending.

They are flawed because they assume normal distributions when there is no basis for having normal distributions. They are flawed because they often use short-term periods of experience when you ought to look all the way through the cycle. And they are even more deeply flawed at a fundamental, philosophical level because they assume each period of human experience is a random sample from a given universe, and it is not. So, even if you solve the other problem, you have not solved the fundamental problem of the distribution between mathematically modifiable probability, risk and uncertainty. So I think they are flawed on many, many levels.

But Japan managed to have the biggest credit and real estate boom of all time before anybody had said here is a value at risk model that you are meant to apply.

Scandinavia had its real estate banking crisis well before people were applying value at risk models. So there are other things going on as well as value at risk models.

What should actuaries focus on? I think the other point that you made about which discount rates to use for what circumstances is a really interesting issue. You said why would anybody use 4%? But actually there is a very interesting debate which broke out after the Stern Report came out. Nick (Aspinall) said you should use the risk-free interest rate plus a very, very small amount for the social preference for present consumption. There may be $2. \pm \text{Epsilons}$ for the 2.01%.

William Nordhaus, who was a very well-respected person, said “No, no. You should use the average rate of return that private investors could get”, because rather than investing in the Severn Barrage they could invest in a new brewery or invest in this or invest in that.

Thinking this through, what is the appropriate approach to long-term investment, especially in an environment where the market is sending us some extraordinary signals?

Despite the significant reversal of some bond yields from extremely low levels over the last week, it is still the case that real risk-free bond yields, which you can obtain on a 30-year index linked bond, which were about 3.5% in 1990, are running at negative levels today.

What does that mean about how society should think about investing in a single great project like the Severn Barrage, which could, if we wanted, give us 5% of our electricity from a completely mature, non-speculative technology?

So far it has always been knocked down by the Treasury on the basis of the Nordhaus approach, that you have to compare the return with the rates of return which companies expect in the private sector.

Is that right, and under what circumstances? I think that this issue is a really crucial one on which we need clarity of thinking.

Mr Aspinall: I think that we have heard some quite radical thoughts, really, about the current structure of our financial system.

Some of the papers cover whether we need a radical approach or whether an incremental approach will suffice. My sense is that we will try the incremental approach first. We are not here to demand a recapitalisation of the banks, although we all have opinions on that point.

The incremental approach might be about incorporating some externality into the discount rate function. That could be a basis for appropriate modification of the actuarial work we do today.